

Sub B1

26. A method for cleaning a semiconductor wafer having a copper layer exposed to a surface thereof after a chemical mechanical polishing, comprising the steps of:

a) treating said semiconductor wafer with a first washer selected from the group consisting of aqueous ammonia containing ammonia at 0.0001 – 0.5 weight percent, a catholyte between neutral and weak base and hydrogen containing water for removing polishing particles from said semiconductor wafer without damage to said copper layer; and

b) treating said semiconductor wafer with a second washer containing at least one decontaminating agent selected from the group consisting of polyaminocarboxylic acids for removing metallic contaminants from said semiconductor wafer.

*A2
Cont*

27. The method as set forth in claim 25 or claim 26, in which a polishing slurry is used during said chemical mechanical polishing, and contains said polishing particles and at least one oxidizing agent serving as a contamination source for at least one of said metallic contaminants.

28. The method as set forth in claim 27 in which said polishing particles are brushed away from said semiconductor wafer, and said first washer allows said polishing particles and said surface to be negatively charged.

29. The method as set forth in claim 25 or 26, in which said catholyte is produced through an electrolysis in one of pure water and aqueous ammonia containing ammonia equal to

or less than 0.5 weight percent.

Sub B1

30. The method as set forth in claim 29, in which said catholyte contains said ammonia at 0.0005 – 0.01 weight percent.

*A2
cont*

31. The method as set forth in claim 26 in which said hydrogen-containing water is produced through a hydrogen bubbling in one of pure water and aqueous ammonia containing ammonia equal to or less than 0.5 weight percent.

32. The method as set forth in claim 31, in which said hydrogen-containing water contains hydrogen at 0.1 - 10 ppm.

33. The method as set forth in claim 32 in which said hydrogen-containing water further contains said ammonia at 0.0005 – 0.01 weight percent.

34. The method as set forth in claim 25, in which said polycarboxylic acids are oxalic acid, citric acid, D-tartaric acid, L-tartaric acid, malonic acid, malic acid malein acid or succinic acid.

35. The method as set forth in claim 25 in which said ammonium salts are salts of oxalic acid, citric acid, D-tartric acid, L-tartaric acid, malinic acid, malic acid, malein acid or succinic acid.

Sub B1

36. The method as set forth in claim 26, in which said catholyte and said hydrogen-containing water has an oxidation-reduction potential between -1000 milli-volt and -300 milli-volt when a reference electrode is formed of silver chloride.

*A2
cont*

37. The method as set forth in claim 25, in which said catholyte has an oxidation-reduction potential between -1000 milli-volt and -300 milli-volt when a reference electrode is formed of silver chloride.

38. The method as set forth in claim 28, in which said surface is formed of an insulating material selected from the group consisting of silicon oxide, benzocyclobutene, parrylene-N, cytop, xerogel, hydrogen silsesquioxane and methylsilane based composite material containing hydrogen peroxide.

39. The method as set forth in claim 25 or 26 in which said second washer is supplied to a major surface of said semiconductor wafer where said copper layer is exposed, and a third washer containing hydrofluoric acid and hydrogen peroxide is supplied to a reverse surface of said semiconductor wafer.

40. The method as set forth in claim 39, in which said hydrofluoric acid, said hydrogen peroxide and water are regulated to 1-10 : 1-10 :200.

Subb1

41. The method as set forth in claim 25 or 26, in which a centrifugal spray

cleaning technique is used in said step b).

An

42. A method for cleaning a semiconductor wafer having a tungsten layer

cont

exposed to a surface thereof after a chemical mechanical polishing, comprising the steps of:

a) treating said semiconductor wafer with a first washer selected from the group

consisting of aqueous ammonia containing ammonia at 0.0001 – 5 weight percent and a catholyte

between neutral and weak base for removing polishing particles from said semiconductor wafer

without damage to said tungsten layer; and

b) treating said semiconductor wafer with a second washer containing at least one

decontaminating agent selected from the group consisting of oxalic acid, ammonium oxalate and

polyaminocarboxylic acids and ranging from 0.01 weight percent to 7 weight percent for

removing metallic contaminants from said semiconductor wafer.

43. A method for cleaning a semiconductor wafer having a tungsten layer

exposed to a surface thereof after a chemical mechanical polishing, comprising the steps of:

a) treating said semiconductor wafer with a first washer selected from the group

consisting of aqueous ammonia containing ammonia at 0.0001 – 5 weight percent, a catholyte

between neutral and weak base and hydrogen containing water for removing polishing particles

from said semiconductor wafer without damage to said tungsten layer; and

SB BY

b) treating said semiconductor wafer with a second washer containing at least one decontaminating agent selected from the group consisting of polyaminocarboxylic acids and ranging from 0.01 weight percent to 7 weight percent for removing metallic contaminants from said semiconductor wafer.

*Ar
cont*

44. The method as set forth in claim 42 or 43, in which a polishing slurry is used during said chemical mechanical polishing, and contains said polishing particles and at least one oxidizing agent serving as a contamination source for at least one of said metallic contaminants.

45. The method as set forth in claim 44, in which said polishing particles are brushed away from said semiconductor wafer, and said first washer allows said polishing particles and said surface to be negatively charged.

46. The method as set forth in claim 42 or 43 in which said catholyte is produced through an electrolysis in one of pure water and aqueous ammonia containing ammonia equal to or less than 5 weight percent.

47. The method as set forth in claim 43, in which said hydrogen-containing water is produced through a hydrogen bubbling in one of pure water and aqueous ammonia containing ammonia equal to or less than 5 weight percent.

Sub B1

48. The method as set forth in claim 45, in which said surface is formed of an insulating material selected from the group consisting of silicon oxide, benzocyclobutene, polyimide-N, cytop, xerogel, hydrogen silsesquioxane and methylsilane based composite material containing hydrogen peroxide.

A

49. The method as set forth in claim 42 or 43, in which said second washer is supplied to a major surface of said semiconductor wafer where said tungsten layer is exposed, and a third washer containing hydrofluoric acid and hydrogen peroxide is supplied to a reverse surface of said semiconductor wafer.

50. The method as set forth in claim 49, in which said hydrofluoric acid, said hydrogen peroxide and water are regulated to 1 - 10 : 1- 10: 200.

51. The method as set forth in claim 42 or 43, in which a centrifugal spray cleaning technique is used in said step b).--

REMARKS

The present application is a divisional application of copending U.S. Patent application Serial No. 09/313,027, ("027 application"), filed on May 17, 1999.